

TABLE 2.—*Tabulated data*—Continued

ROSWELL, N. MEX.—Continued

[105th mer.]

MARCH 15, 1928

Time	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
A. m.	M.	Mb.	°C.	°C.	P. ct.	Mb.	nw.	M. p. s.	
5:54	1,098	882.6	7.6	—	68	7.93		4.9	6 St. Cu., W.
	1,250	866.3	7.2	—	68	6.91			
5:55	1,462	844.3	6.6	0.27	68	6.62			
	1,500	840.5	6.2	—	68	6.45			
	2,000	790.7	1.3	—	70	4.70			
5:58	2,360	755.8	—2.3	0.99	72	3.64			Adiabatic.
	2,500	742.5	—3.3	—	73	3.39			
	3,000	697.0	—6.7	—	76	2.65			
6:01	3,368	664.8	—9.3	0.70	79	2.20			Adiabatic.
	3,500	653.8	—9.3	—	79	2.20			
6:02	3,568	648.0	—9.3	0.00	79	2.20			Isothermal.
	4,000	612.2	—12.7	—	78	1.61			
	4,500	573.7	—16.7	—	76	1.09			
6:06	4,949	540.5	—20.3	0.79	75	0.78			
	5,000	536.6	—20.7	—	75	0.74			
	6,000	468.3	—28.3	—	74	0.34			
6:10	6,220	454.3	—30.0	0.76	74	0.28			
	7,000	406.6	—38.4	—	70	0.10			
6:13	7,088	401.3	—39.3	1.07	70	0.10			Superadiabatic.
6:14	7,552	375.2	—39.8	0.11	70	0.09			
	8,000	351.9	—44.6	—	67	0.05			
6:19	8,134	344.9	—46.1	1.08	66	0.04			Superadiabatic.
	9,000	303.2	—42.9	—	64	0.06			
6:22	9,515	281.6	—41.0	—0.37	63	0.07			Inversion.
	10,000	262.5	—41.7	—	63	0.06			
	11,000	226.9	—43.2	—	64	0.06			
	12,000	195.8	—44.8	—	65	0.05			
	13,000	168.5	—46.3	—	66	0.04			
6:32	13,019	168.0	—46.3	0.15	66	0.04			
6:34	13,956	145.7	—52.4	0.65	66	0.02			

SAN ANTONIO, TEX.

[90th mer.]

MARCH 14, 1928

P. m.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity	Wind	Remarks
					Relative	Vapor pressure	
7:35	230	980.5	24.0	—	64	19.11	10 St., NW.
	250	978.2	23.9	—	64	19.00	
	500	950.5	22.1	—	68	18.10	
	750	923.6	20.3	—	72	17.16	

TABLE 2.—*Tabulated data*—Continued

SAN ANTONIO TEX.—Continued

[90th mer.]

MARCH 14, 1928—Continued

Time	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity		Wind		Remarks
					Relative	Vapor pressure	Direction	Velocity	
P. m.	M.	Mb.	°C.	°C.	P. ct.	Mb.		M. p. s.	
7:37	889	911.0	19.4	0.72	74	16.68			
	1,000	897.2	19.1	—	68	15.04			
7:38	1,135	883.2	18.8	0.23	62	13.46			
	1,250	871.2	18.0	—	62	12.80			
	1,500	840.0	16.3	—	61	11.31			
7:41	1,880	809.3	13.6	0.70	60	9.35			
	2,000	797.8	13.6	—	54	8.41			
7:45	2,352	765.3	13.6	0.00	37	5.76			Isothermal.
	2,500	752.4	12.7	—	36	5.29			
	3,000	709.2	9.6	—	30	3.58			
	3,500	667.0	6.5	—	25	2.42			
7:52	3,546	663.1	6.2	0.62	25	2.37			
	4,000	626.8	1.5	—	28	1.91			
7:58	4,447	593.2	—3.2	1.04	30	1.41			Superadiabatic.
	4,500	589.4	—3.7	—	30	1.35			
	5,000	553.4	—8.7	—	30	0.88			
8:06	5,254	535.1	—11.3	1.00	30	0.70			Adiabatic.
	6,000	485.7	—18.2	—	28	0.35			
8:14	6,188	473.8	—19.9	0.92	27	0.28			Adiabatic.

MARCH 15, 1928

A. m.	Altitude, M. S. L.	Pressure	Temperature	$\frac{\Delta t}{100 \text{ m.}}$	Humidity	Wind	Remarks
					Relative	Vapor pressure	
6:55	230	981.4	20.9	—	90	22.26	10 St., SE.
	250	979.0	20.7	—	90	21.99	
6:56	478	953.6	18.8	0.85	95	20.62	
	500	951.0	18.9	—	95	20.76	
	750	924.2	19.5	—	93	21.09	
6:59	1,000	897.6	20.1	—	91	21.42	
	1,150	882.3	20.5	—0.25	90	21.72	Inversion.
	1,250	872.2	20.0	—	90	21.06	
	1,500	847.5	18.7	—	90	19.42	
	2,000	799.3	16.1	—	90	16.47	
	2,500	753.4	13.5	—	90	13.63	
7:03	2,620	742.9	12.9	0.52	90	13.39	
	3,000	710.4	9.2	—	90	10.48	
	3,500	668.5	4.4	—	89	7.44	
7:07	3,666	654.8	2.8	0.96	89	6.65	Adiabatic.
	4,000	628.0	0.0	—	89	5.44	
7:13	4,039	625.1	—0.3	0.83	89	5.30	

SUPERSATURATION AND ICING OF AIRPLANES

By W. J. HUMPHREYS

[Weather Bureau, Washington, June, 1930]

Aviators have reported occasional instances of very rapid icing of their planes while in flight. Even the term "explosive rapidity" has been used to indicate the apparent suddenness of this phenomenon. It also has been asserted that such exceptionally rapid accumulation is owing to supersaturation in an undercooled cloud with respect to any film of ice that may be on the wings and other portions of the "ship." This sounds learned and also fits the observations perfectly. But before accepting this enticing explanation as necessary and sufficient to account for the alleged facts let us first try on it the touchstone of figures.

Suppose, to be liberal, that the temperature is -10°C. , the cloud particles still liquid droplets, and that the plane flying through this cloud has on it a film of ice. What will be the rate of ice accumulation on the front edge of the wings by condensation?

From the Smithsonian Physical Tables, and elsewhere, it appears that at -10°C. the vapor pressure over water is, in terms of the height of a balancing column of mercury, 2.144 millimeters, and over ice 1.964 millimeters, that is,

less by 0.180 millimeters. Furthermore, from the same source we find that at -10°C. and in the presence of ice, the weight of vapor necessary to saturate a cubic meter is 2.158 grams. Hence the number of grams of water vapor necessary to add to a cubic meter saturated at -10°C. in the presence of ice, to render it saturated at the same temperature in the presence of only undercooled water is given by the equation

$$\frac{180}{1964} = \frac{x}{2.158}$$

from which x , the amount in question, is .198 grams, nearly. It may be argued that as this applies to water having a flat surface, the standard for saturation determinations, the difference in the presence of droplets only, as in a cloud, would be greater. This is true, but for droplets of this size the difference is negligibly small.

If, then, a plane caught up all the excess, or supersaturation, vapor "encountered" in passing through a cloud undercooled to -10°C. the load would be .198 grams per square centimeter vertical cross section, per

cubic meter swept out by that square centimeter, or, in other words, per each 10 kilometers flight in such cloud. Or, what comes to the same thing, he would have to fly, under these conditions, 72 miles or thereabouts, to accumulate a layer of clear ice an inch thick on the front of the plane. Of course, though, nothing like all the excess vapor encountered would be condensed on the plane. Perhaps not a tenth of it. At any rate, condensation of

the excess vapor in an undercooled cloud can not load an airplane with explosionlike rapidity. In fact the amount of icing from this source probably is negligible.

As stated above, the condensation explanation of the icing of airplanes may seem at first to be sound and sufficient, but like many another explanation that has found its way into popular literature (and some, too, that isn't so popular) it was just jumped at—and missed a mile.

RELATIONS BETWEEN WINTERS IN MANITOBA AND THE FOLLOWING SPRING IN EASTERN UNITED STATES

By FRED GROISSMAYR

[Passau, Germany]

In various publications¹ I have given, as I believe, solid bases for a winter temperature forecast in the interior of Canada from the Winnipeg-Lake region to Saskatchewan; further investigations on Canadian seasonal temperature forecasts had given me the interesting result that the winter temperature at Manitoba is a very useful indicator for the immediately following spring on the Great Lakes province and the New England States as well as for a large area bounded in the west by the Mississippi, in the east by the Atlantic, and in the south about by the thirty-fifth parallel of north latitude. For this investigation I used the 50-year series 1874–1923. The correlations are as follows:

Δt I–II Winnipeg 1873–74 with following Δt III–V: 1874–1923.

Winnipeg	0.59	Detroit	0.43
Marquette	0.63	New York	0.53
Chicago	0.45	Omaha	0.37
Toronto	0.65	Key West	0.00
Albany	0.47	Cheyenne	0.04
Cincinnati	0.39	Portland, Oreg.	0.08
Eastport	0.49	Mobile	0.26
Nashville	0.29	San Diego	0.02
New Haven	0.58	Galveston	0.05
St. Johns	0.31	San Francisco	0.11

A still better combination, however, is Δt I–II Winnipeg 1874–1923 with Δt III–IV: Winnipeg 0.52.

Low to Westward:		High to Eastward—Con.	
Portland	0.11	New York	0.66
Denver	0.16	Albany	0.64
San Diego	0.05	Baltimore	0.63
Galveston	0.06	Pittsburgh	0.51
High to Eastward:		$r \geq 0.60$:	
Marquette	0.74	St. Louis	0.49
Toronto	0.73	Omaha	0.47
Chicago	0.60	Nashville	0.35
Boston	0.66	Mobile	0.32
Eastport	0.51	Key West	0.03
New Haven	0.71		

The next table shows the numerical departure of Δt I–II at Winnipeg and those of Δt III–IV, 1874–1923: (1) For Δt III–IV (Marquette and Toronto divided by 2); (2) for Δt III–IV (New York plus New Orleans, plus Cincinnati and Milwaukee divided by 5).

¹ Relations between summers in India and winters in Canada, Mo. Wea. Rev. 57: 455–56. See also Neue Erkenntnisse im Zusammenhange des Welt-Wetter. Analen der Hydrographie, April, 1930.

Year	Δt I–II Winnipeg	Δt III–IV Great Lakes	Eastern United States	Year	Δt I–II Winnipeg	Δt III–IV Great Lakes	Eastern United States
1874	–0.5	–4.8	–3.3	1901	–0.2	+1.8	–0.6
1875	–11.3	–5.7	–4.2	1902	10.5	+4.6	+1.6
1876	–6.3	–3.0	–2.1	1903	+4.1	+4.8	+3.3
1877	+5.5	–1.5	–1.6	1904	–3.9	–2.2	–1.7
1878	+17.1	+9.0	+5.8	1905	–0.3	+0.3	+2.0
1879	–4.5	–0.1	+0.4	1906	+5.9	+0.1	–1.9
1880	+0.7	–0.6	+0.9	1907	–1.8	–1.0	+0.4
1881	–2.0	–1.6	–3.0	1908	+9.8	+0.5	+3.2
1882	+3.3	+0.1	+2.0	1909	+0.4	–1.2	–0.4
1883	–9.6	–5.5	–1.5	1910	+3.5	+8.0	+5.5
1884	–9.6	–2.3	–0.8	1911	–0.3	+1.6	+0.5
1885	–8.9	–8.1	–3.5	1912	–1.0	–2.3	–1.6
1886	–5.8	+1.1	–0.2	1913	–2.3	+1.0	+0.6
1887	–9.9	–4.0	–0.6	1914	+1.0	–0.6	–1.5
1888	–7.3	–6.3	–1.9	1915	+9.0	+4.8	+0.1
1889	+2.2	+3.0	+1.6	1916	–1.4	–1.7	–1.8
1890	–8.1	–1.2	–1.0	1917	–5.4	–0.7	–0.3
1891	+1.8	–0.3	–0.9	1918	–0.1	+2.8	+1.7
1892	–1.0	–1.7	–2.3	1919	+9.0	+2.4	+1.0
1893	–7.8	–2.8	–0.9	1920	+2.5	+0.1	–1.0
1894	–0.5	+4.3	+3.1	1921	+10.5	+6.5	+6.0
1895	–2.3	–1.5	–0.3	1922	+3.2	+3.2	+2.0
1896	+2.4	+0.1	+0.7	1923	+2.8	–0.7	–3.6
1897	+1.1	+0.8	+0.8				
1898	+5.9	+4.4	+1.0				
1899	–4.3	–1.2	–1.0				
1900	+2.1	–0.4	–0.8				

We further find the remarkable fact, that in all cases, in which the combined January–February temperature at Winnipeg had a pronounced character (departure 6.0; standard deviation 6.01 F.), the following combined March–April in the Lake region as well as in eastern United States had the same departure. In this 50-year series we have 15 *pronounced* Winnipeg January–February departures that is in 30 per cent. In the table I have indicated these by bold-face type.

The correlations: Δt I–II W. with Δt III–IV Lake area or first group is 0.75. For eastern United States or the second group 0.60.

The regression equations are:

First group Δt III–IV = 0.433 Δt I–II W. F.

Second group Δt III–IV = 0.227 Δt I–II W. F.

It is a noteworthy, but notwithstanding physically founded fact, that even the stations in North Dakota, as well as Winnipeg itself, are much less influenced than the far countries on the Atlantic; even New York's March and April temperatures are much more influenced by the preceding Januaries and Februaries in Manitoba,